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CHEMICAL & ENGINEERING

NEWS

Minorities in Science

Efforts are growing to increase participation of historically underrepresented groups

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NEWS
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News of the Week

■ **Key new findings in C_{60} chemistry have been made, including confirmation from x-ray crystallography that a fullerene is shaped like a soccer ball.** Page 4

■ **NAS report urges strong action to reduce greenhouse gas emissions to the atmosphere despite continuing uncertainties about the threat of global warming.** Page 5

■ **Many questions surround destruction of Iraq's chemical weapons capabilities, called for in UN cease-fire resolution.** Page 5

■ **Destruction of Earth's protective ozone layer apparently is speeding up, ongoing NASA studies of satellite data indicate.** Page 6

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Business

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LETTERS

Expenditure clarification

Du Pont seeks to clarify its R&D expenditures reported in the table on page 13 of the article, "Chemical Industry R&D Spending To Increase Modestly" (C&EN, Jan. 21, page 11).

To compare Du Pont's 1991 R&D expenditures estimate with 1990 actual, you must exclude pharmaceuticals-related research that was in Du Pont in 1990 but transferred in 1991 to the new Du Pont Merck Pharmaceuticals, a separate company formed on Jan. 1.

Consequently, the restated 1990 figure without pharmaceuticals is $1.15 billion and the 1991 estimate is $1.22 billion, an increase of about 6%. (If pharmaceuticals-related research had remained in Du Pont in 1991, the total R&D increase would have risen at a similar percentage.)

John L. Stowell
Du Pont, Wilmington, Del.

ACS member involvement

I read all of new President Allen Heininger's message (C&EN, Jan. 7, page 2) quite carefully. I found a great deal to agree with, particularly in the field of education. But when he suggests streamlining the governance of ACS, I departed sharply.

He seems to be complaining that there are a large number of committees, subcommittees, boards, etc., as though that is something inappropriate. Perhaps it would be, for a business, but ACS is not a business. It is a 501 C3 membership organization. A membership organization serves its members best when there is extensive membership participation. This is one way to ensure it. It also helps us to attract new members and retain existing members.

If one looks at the first page of the ACS Directory of Governance (the "Yellow Book") one sees right at the top of the diagram of "Governing Bodies of the ACS" a box that says, "Membership of the ACS"—indicating that the members are the boss. The effective participation of so many ACS members in its governance constitutes a strength. It is not a weakness. After all, the first responsibility of ACS is to its own members and this is one way to ensure it.

Not that one shouldn't always be looking for better and more efficient ways of taking care of the society's affairs, and of making it more representative and more constructive. The society does have a disproportionate number of academics in its governance. It does not have a proportionate share of bachelor's and master's degrees in its ruling circles. This is something that has to be constantly kept in mind for correction, as Heininger acknowledges.

But the members are not well served if their professional and economic health is not adequately addressed. One of past-president Paul Gassman's major concerns seemed to have been to reduce the influence of the council in these matters by blending the committees of Professional Relations, Economic Status, and Professional & Member Relations into a supercommittee—in which councilors would have less influence—and to eliminate PROPPACC. I think this would be unwise. These are precisely the committees that are most vigilant in representing the interests of the vast majority of our members and are so perceived to be. Not that these committees are immune from error, but who is? Eliminating the council would work against some of the goals that our new president says he's for, to improve our concern for nondoctorate and industrial members. We should retain these committees and work to get more non-Ph.D.s to become councilors so they could become members of committees. Also, presidents-elect, who are responsible for appointments, should be sensitive to the need for such action.

I foresee rather difficult times for chemists in the next few years as the recession deepens and the new board-favored immigration laws, which will allow a flood of foreign chemists into the country, come into effect in 1993. So I feel this is a particularly poor time to weaken member involvement in ACS.

Alan C. Nixon
Berkeley, Calif.

Antiwar protests

The article on antiwar protests by scientists (C&EN, Jan. 21, page 5) cannot be left to suggest that all, or even many, scientists are against the allied actions against Saddam Hussein in the Persian Gulf War. While the motives of scientists like Linus Pauling and Dudley Herschback are not in question, their actions reveal a startling naiveté about humanity.

The statement that "sanctions and a sustained diplomatic siege" could produce results was discounted uniformly as it was realized that Hussein and his army would retain whatever was left in Iraq and only civilians would suffer from shortages. Six months of sanctions produced no effects, and the routes for bridging the trade embargoes became clearly uncontrollable. These arguments

MINORITIES IN SCIENCE

Growing effort aims to increase participation of historically underrepresented groups

Rebecca L. Rawls, C&EN Washington

There are 54 million blacks, Hispanics, American Indians, and Alaskan natives living in the U.S., 22% of the total population. Members of these ethnic groups are generally poorer, less well educated, and much less likely to be scientists or engineers than are people from the other 78% of the population. In 1988, only 4.4% of the 4.5 million people employed as natural scientists or engineers in the U.S. were members of these minority groups.

Yet these groups are also among the fastest growing segments of the U.S. population. Blacks and Hispanics, who accounted for 25% of school-age children in 1988, will represent 47% of that group by the year 2020. For the remainder of the decade, 42% of the new entrants into the labor force are expected to be minorities, according to estimates made by the Department of Labor.

At the same time, science and engineering careers are becoming much less attractive to middle-class white males, the group that traditionally has produced most of our scientists and engineers. The National Science Foundation estimates that by the year 2010, the U.S. could suffer a shortfall of as many as 560,000 science and engineering professionals, based on the levels that would have been produced had graduation rates in these fields remained at their 1984–86 levels.

These forces have come together to produce what some observers are calling a window of opportunity for efforts to increase minority participation in the sciences and engineering. A major new federal initiative spearheaded by NSF has been coupled with increased efforts from industry consortia and professional societies and with greater funding for programs already in place that have proven records of success. All these activities point to a new climate for attracting minorities to science careers.

The rationale for this effort is straightforward. As Erich Bloch, then director of NSF, put it last fall, "Our world is increasingly competitive, and our economy increasingly depends on scientific and technical excellence. That excellence, in turn, depends on people—people with education and skills in every area of science and technology.

"More and more, a focus on people means a focus on minorities, because minorities are a resource we have not fully used. Minorities have not been drawn to science and engineering in sufficient numbers, and earn far fewer advanced degrees in science and engineering than their relative numbers in the population would indicate."

The underrepresentation of certain ethnic groups in science and engineering has always been a matter of concern to some, because it implies a lack of equal opportunity for all Americans that is contrary to the ideals of a democratic society. And a number of organizations—notably the National Institutes of Health and

calculate the electronic structures of large molecules and in some cases even their reaction pathways. Theory has reached the point where chemists can actually predict many aspects of molecular structure and reactivity. During the course of my career I have seen theoretical chemistry emerge as a major subfield of chemistry.

Experimental chemical physics has been revolutionized by lasers. Lasers allow us to examine chemical reactions that occur very rapidly, reactions that only take trillionths or even fractions of trillionths of seconds. Thanks to lasers, it is now possible literally to see the primary events of chemical reactions, the very first movements of atoms as they separate from molecules. This sort of fundamental understanding of the reactions of molecules is truly phenomenal.

The work of inorganic and organic chemists has been changed completely by advances in synthesis technology. Our ability to design and synthesize whole new classes of molecules will lead to dramatic breakthroughs in medical science. This ability also will provide the materials that will be required for molecular memory. In discussing this area, Richard Feynman predicted that molecular memory will allow us to increase the speed of today's supercomputers a millionfold or even more! I like the idea that chemistry will provide the super-supercomputers of the future.

The importance of fundamental research in chemistry will be highlighted in the 1990s by responses to a multitude of environmental issues. Chemists will be called upon time and time again to replace dangerous chemicals with safer ones. Research that may lead to the replacement of hydrofluoric acid by less toxic acids (solid superacids?) and chlorofluorocarbons by molecules that are less threatening to stratospheric ozone is being done because of very real concerns about the environment. And more and more energy research will be directed toward the production of fuels that can reduce the risk of global warming.

We will see renewed research initiatives in artificial photosynthesis. It is our hope that we can make molecules that will affect the direct conversion of sunlight and very abundant raw materials directly into high-energy chemicals, directly into fuels that we can use to heat homes, make electricity, run cars, and so forth. Those of us who work in this field hope that by the end of the decade some of this research will have reached an advanced stage of development and will have begun to have some impact.

A main goal of artificial photosynthesis is to use solar photons to split water to hydrogen and oxygen. Hydrogen is very energy-rich; and it is a clean-burning fuel, giving only water as the product. Pollution problems would be reduced tremendously if we burned hy-

Continued on page 39

Solutions.

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3M

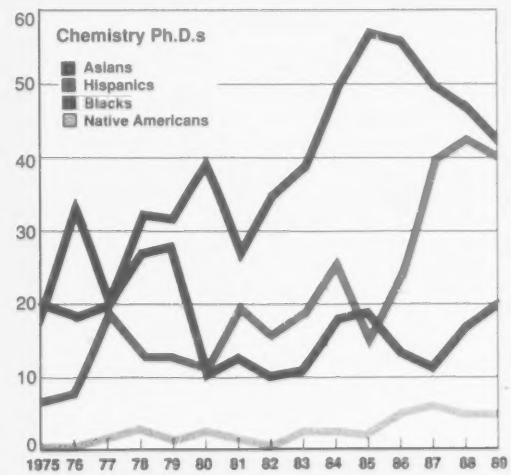
Minority Ph.D.s in natural sciences and engineering are increasing slowly . . .

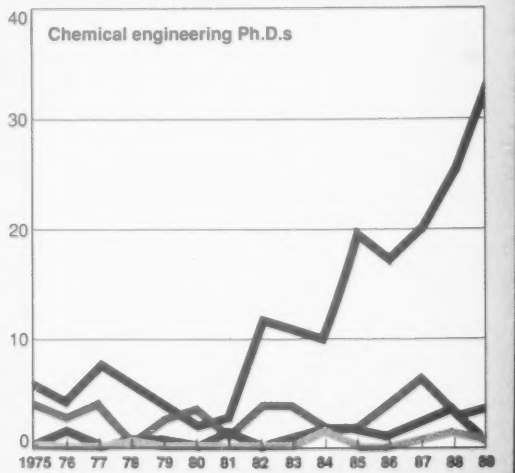
	1989	1988	1987	1986	1985	1984	1983	1982	1981
NATURAL SCIENCES & ENGINEERING									
Whites	7846	7817	7361	7329	7383	7476	7433	7525	7274
Asians	416	362	362	323	304	311	275	257	249
Hispanics	174	187	152	137	117	118	96	107	90
Blacks	108	96	93	86	98	102	94	87	99
Native Americans	34	27	30	31	22	21	14	18	13

. . . but absolute numbers of Ph.D.s remain very low in chemically related fields

	1989	1988	1987	1986	1985	1984	1983	1982	1981
CHEMISTS									
Whites	1161	1235	1243	1182	1219	1189	1248	1191	1102
Asians	42	47	49	56	57	50	39	35	26
Hispanics	40	43	40	24	14	26	19	15	20
Blacks	20	17	11	13	19	18	11	10	13
Native Americans	5	5	6	5	2	3	3	0	1
CHEMICAL ENGINEERS									
Whites	305	293	243	195	181	143	140	113	118
Asians	33	26	20	17	20	10	11	12	3
Hispanics	4	3	7	4	2	2	4	4	1
Blacks	1	4	3	1	2	2	1	0	2
Native Americans	1	2	1	0	0	2	0	0	0
BIOCHEMISTS									
Whites	437	400	384	412	431	463	510	509	501
Asians	24	15	18	23	21	17	17	17	16
Hispanics	9	12	14	11	5	3	6	5	6
Blacks	4	7	6	5	4	4	5	4	8
Native Americans	1	0	0	2	2	1	0	0	1

Note: Data are for U.S. citizens. Natural sciences include agricultural and biological sciences, earth and atmospheric sciences, physical sciences, mathematics, and computer sciences.

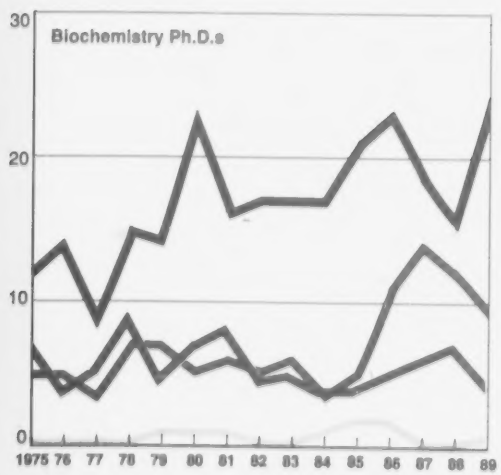




1980	1979	1978	1977	1976	1975
7233	7244	6986	7438	7776	8142
241	234	222	187	197	158
75	90	79	89	64	74
85	106	117	93	93	101
14	10	14	15	3	5

1980	1979	1978	1977	1976	1975
1023	1078	1013	1116	1163	1281
40	32	33	19	34	18
11	13	13	19	8	7
10	28	27	20	18	20
3	1	3	2	0	0
110	123	112	136	137	171
2	4	6	8	4	6
4	3	0	4	3	4
0	1	1	0	2	0
0	0	1	0	0	0
510	448	438	465	453	461
23	14	15	8	14	12
5	7	7	3	5	5
7	4	9	5	3	7
1	1	0	0	0	0

Source: National Science Foundation



groups from fully participating in science careers? Here are the opinions of some people who have been there:

"The number one barrier is lack of academic success, which is generic. It goes beyond science, but you can't do science without being academically successful," says George Castro, president of the Society for Advancement of Chicanos and Native Americans in Science (SACNAS). Castro, a chemist of Mexican descent, is a manager of research at IBM's Almaden Research Laboratories in San Jose, Calif.

"It's a common problem," Castro says, "that the minorities of color face in this country; they have an education system that does not serve them well. There are lots of factors having to do with the curriculum, the teachers, the home environment, and the culture and history of the family toward education and their knowledge of it. Native Americans and Mexican Americans mainly have a background of poverty. Their parents know very little about higher education, don't have much education themselves, and are not prepared to set the intellectual environment at home that causes their children to excel. That's very different from middle-class people in the rest of the world."

Says James W. Mitchell, a black chemist who heads the analytical chemistry research department at AT&T Bell Laboratories in Murray Hill, N.J.: "There are only three things that make kids want to excel. The three things are parents who are aware enough about what is necessary to instill in children the self-esteem, the confidence, and the expectations that they need to have, and to provide them with the discipline that is necessary to take advantage of what the schools can offer them. You need teachers who expect high levels of performance from students and who care about the quality of the product they turn out. And you need the interactions of the parents with the students and the teachers. Then all the other things fall into place.

"My children have gone to a public school, and they perform well because their parents are aware of what they need to do with the teachers and with the kids so that the kids will perform. Unfortunately, for every one set of minority parents who understands and does what's necessary, 10,000 parents either don't understand or can't communicate it in a way that the teachers understand. Therefore, those kids are being lost, and only one gets through."

Norbert S. Hill Jr., an Oneida indian and director of the American Indian Science & Engineering Society (AISES), says: "I don't think public schools do a decent job for white kids; they certainly aren't going to do a decent job for black kids or Indian kids. What's happened in the schooling of people of color has been a process of alienation. There is a lot of violence in the schools, not only physical violence, but psychological and spiritual violence as well, that makes our people unwelcome."

And Marcus Cheney, a Yaki indian and instructor of chemistry at California State University, Northridge, comments, "I don't think all educators are the same, but most of them are. They have no clue about where we are coming from."

Such personal perceptions find support in more for-

Asians are an atypical minority among scientists

Asians are usually thought of as the atypical minority group among scientists and engineers. Unlike blacks, Hispanics, and American Indians, Asians make up a larger fraction of scientists and engineers in the U.S. than they do of the general population. According to data from the National Science Foundation, there were 36,400 Asian doctoral scientists or engineers in the U.S. in 1987, or 9% of the total. By contrast, Asians represent 3% of the work force in professional fields and only about 2% of the overall U.S. work force.

Since 1978, employment of Asian scientists and engineers has been growing 9% per year, or 146% through 1988, which is much faster than the 7% per year growth (or 97% overall) in scientific and engineering employment for whites over the same period. And Asians are more likely than whites or other ethnic minorities to be chemists if they are scientists—13% compared with 8% for all racial groups combined. At the Ph.D. level, 20% of Asian scientists are chemists, compared with 13% of Ph.D. scientists of all races. Asians are also more likely than people of other ethnic groups to have Ph.D. degrees in engineering—35% of Asian Ph.D. scientists and engineers are engineers, compared with only 16% from all races.

But this first-glance picture can be somewhat deceiving. Of the Asian Ph.D. scientists and engineers working in the U.S., one in three is not a U.S. citizen, and of those who are, 85% were not born in the U.S. Thus, 90% of these scientists and engineers are immigrants to the U.S. Some came as children with their parents, but a significant fraction came to the U.S. specifically to study science or engineering in college or graduate school and stayed on.

According to Betty M. Vetter, executive director of the Commission on Professionals in Science & Technology, Asians account for 2% of the U.S.-born science and engineering Ph.D.s in the U.S., a fraction that is the same as their representation within the population. U.S.-born Asians earn Ph.D.s in all fields at a rate that is slightly below their representation in the population, Vetter says, but because they are more likely to earn those degrees in science and engineering than other groups are, they end up equitably represented among Ph.D. scientists and engineers.

"Stereotypes abound about the intelligence and educational achievements of Asian-American children, [but] a closer look suggests that reality is far more complicated than perceptions," says a 1988 report by the Congressional Office of Technology Assessment entitled "Educating Scientists and Engineers." The report concludes that "a lack of research on the interaction of country of origin, social class, and family structure with educational success inhibits understanding of Asian-American participation in the science and engineering work force."

One thing that is clear is that the composition of the Asian community in the U.S. is changing. Most Asian immigrants to the U.S. in the late 1960s and early 1970s came from Hong Kong, South Korea, India, and the Philippines, following a liberalization of immigrant quotas from these countries in 1965. This wave was followed by more than 100,000 Indo-Chinese, primarily Vietnamese, who came to the U.S. following the end of the Vietnam war in 1975. Both of these groups included mostly middle- to upper-income professional people who were fairly well educated, traits that usually indicate that the children of such families will do well in school.

mal studies. For example, the Quality Education for Minorities Project, a joint effort of Massachusetts Institute of Technology and Carnegie Corp. of New York, reported in 1990 that 35 years after the Supreme Court declared segregated schools unconstitutional, most minority children in the U.S. remained in schools that were separate and decidedly unequal. "Quality education is still not available to most minority students, nor is it uniformly available to all nonminority students," the project concluded."

"Our present system of learning ... is clearly inadequate if the nation is to meet the challenges facing us in the 21st century. But for minority students, our educational system is not merely inadequate; it is, all too often, openly hostile and damaging," the report continues.

In a study for Rand Corp. in 1989, Jeannie Oakes, now an associate professor of education at the University of California, Los Angeles, found that the quality of math and science education in secondary schools decreases in direct relation to the number of minority students in the school. Schools with the highest minority enrollments also have the lowest average family income and are much more likely to be located in inner cities. Their resources are fewer, and they offer fewer math and science courses per 1000 students than do schools that have predominantly white students.

For instance, 50% of the schools in her study with 90% or more minority enrollment did not offer calculus as a high school course, compared with 80% that did offer it among schools that were 90% or more white. Teachers in high minority schools were less well paid. They were more likely than in predominantly white schools not to be certified and less likely to have bachelor's or master's degrees in the subjects they taught. Even within a particular school, minority children were more likely than whites to be in classes taught by more poorly trained teachers.

"Oakes' study says that minority students have less of everything that you need in order to do well in science," says AAAS's Malcom, "less well-trained teachers, less facilities, less resources, fewer classes at the upper levels. It's very hard to get through the system if you don't even have available to you the things it takes to be successful."

If education in general is poorer for minority students, it is their lack of preparation in mathematics, in particular, that can cut them off at an early age from science careers. Math is essential training in rigorous thinking for the future scientist, says Bertram O. Fraser-Reid, a black professor of chemistry at Duke University. Fraser-Reid, who grew up in Jamaica, attended a high school there that offered neither chemistry nor physics, yet of the eight people in his graduating class, six now

The late 1970s, however, brought an additional 600,000 Indo-Chinese refugees from Vietnam, Laos, and Cambodia, many of whom were in quite different circumstances from the earlier refugees. They tended to be poorer in their homelands and to come to the U.S. with fewer skills and lacking a command of the English language. Data on the educational attainment of the children of these immigrant families is still incomplete, but some early studies suggest these children find it difficult to learn, some are attracted to drugs and gangs, and many are dropping out of school.

Nevertheless, the stereotype is that Asian students are smart, particularly in math and science. At some schools where Asian enrollment is high—like the University of California, Berkeley, for instance, where close to 45% of chemistry and engineering undergraduates are Asian Americans—students informally calculate what they call the "Asian factor" for various course offerings: if an introductory science or math course has too many Asian students enrolled, non-Asians will drop it on the assumption that the Asian students, being better at science and math, will shift the grading curve and make it more difficult to get a good grade in that particular course.

Agnes S. Sec, a Chinese American doctoral candidate in chemistry at the University of Wisconsin, Madison, has examined the performance of U.S.-born Asian students in the general chemistry courses at Wisconsin. In this study of 6653 students taking introductory chemistry in 1988 through 1990, 4.8% of the students were Asian Americans. Sec found the Asian Americans were just as likely as the class in general to get all As, or As and Bs in these courses. They were somewhat less likely than the class as a whole to get Bs or Cs, and they were about 5% more likely to get Ds, fail, or drop out of these courses. She suggests that the very expectation on the part of teachers and fellow students that Asian students will do well in chemistry actually makes it harder for marginal students who are Asian to succeed.

Another study, this one by mathematics professor Uri Treisman of the University of California, Berkeley, suggests that some of the difference between the performance of Asian students and other minorities—at least in mathematics courses—may be based on study habits, rather than on any differences in ability. In the mid-1970s, Treisman compared the backgrounds, campus lives, study habits, and attitudes of 20 black students and 20 Cantonese-speaking Chinese students taking introductory calculus at Berkeley. At that time, blacks were the least likely of all groups on campus to do well in introductory calculus and Chinese students the most likely to do well. He found that early in the semester the Chinese students organized study groups that met regularly after the students had completed their homework. Group members compared homework results and discussed their perceptions of what the professor expected and of their own adjustment to campus life. The blacks, by contrast, studied alone and maintained a rigid separation between their academic and social lives.

Treisman then set up workshops for black students along the model of what the Chinese students were doing. After a decade of evaluation, he finds that black students who are part of such workshops consistently earn higher grades in their calculus courses (a B- average, compared with C- for nonparticipants), rarely drop first-term calculus, and are more likely to graduate and to major in math.

have advanced degrees in science, mainly, he believes, because of the early grounding they got in mathematics.

"Now, for somebody who is a lousy mathematician, I hate to sing the praises of mathematics!" says Fraser-Reid. "But I think the rigorous thinking that one gets in that study is crucial. Let such-and-such be x, then such-and-such happens. And if that isn't done rigorously, if the answer isn't right, then you didn't treat x properly. That is something that I think has to be inculcated and become second nature at a very early age."

"What are the additional things that prevent our people from going into science?" SACNAS's Castro asks. "One of them is getting tracked out of math courses at the high school level. If you don't shoot for algebra by at least the ninth grade, you are pretty much out of the running to be a scientist. It takes a tremendous makeup afterward. Only with algebra by the ninth grade can students get geometry and trigonometry and precalculus and all the other things that are the language of science."

"We get people coming out of high school with little or no mathematics. I think that is the bottom line," says Henry C. McBay, a black professor of chemistry with a joint appointment at Morehouse College and Clark Atlanta University. "The black students are not coming out of high school with the academic tools, the language skills—and I include mathematics as a language. If they can't do English and mathematics, then they can't do chemistry and physics. You can't start at age 16 or 17 to do chemistry or physics if you haven't had mathematics and English all the way up."

Says Joseph G. Danek, director of NSF's human resources development division: "It's a question of access. You can take any population of school children in any part of the world, and if you put them in an environment where the teachers are poorly trained, there is little equipment, the textbooks are old, and they have to deal with all the other things that are found in the schools where a large percentage of our minority population attends, it's no surprise that by age 13 or 14 these children will be behind. What the problem has been, in my personal view, is that the nation isn't willing to face these problems up front and accept the cost of modifying, restructuring, and changing the quality of education in the urban school."

"But worse than that, we've created an artificial situation in which there are no alternative pathways to successful careers except for children to do well in a very short window that begins at the seventh grade," Danek continues. "By the time they are 17 years old, they are either in or out; if they don't perform within those years, they won't get into a good college or they won't get into college at all, and everything closes down for them. We

Malcom (left): equal access to the enterprise called science. Castro: a great community to belong to

have a mind-set that says, according to the traditional pipeline, you have to progress according to this norm."

Minority students aren't alone in having to deal with these problems of the education system. "Most of the things that happen to black and Hispanic children, to American Indian children, probably aren't unique to them," Malcom says. "It's the accumulation of bad stuff that is unique, something that I think our society is doing to them. If you believe that the process of producing a scientist is one of cumulative advantage, with what these kids have, it ought to be amazing that anybody gets through. What they have is cumulative disadvantage."

In fact, when talking to minority scientists, it's easy to get the impression that in many cases, it was only by extraordinary luck that they became scientists. Every case is different, but Castro's can serve to illustrate how it happens. He credits a temporary move by his family from the inner city to a white suburb for setting in motion the process that led him to a research career in chemistry.

He says: "I was attending a junior high school in East Los Angeles that was a typical ghetto school at that time; that is, it had hardly any white people. It was primarily Mexican, black, some Japanese, some Jewish. I was there with the Mexican and black kids. I didn't notice I wasn't in class with Jewish or Japanese kids. I knew they were in the school, but I didn't understand why we weren't in the same classes; in fact, I didn't even notice it.

"Then for one semester, we moved out to a suburb, and I ended up in a school that was practically all white, in a class where there was one other Mexican student and myself, all the rest were white. This was the eighth grade, and the whole class started to prepare to take algebra in the ninth grade. So I started doing that, and then my parents moved back and I went to my old school again. Since I had gotten geared up to take algebra, I signed up to take it back in my old ghetto school. And then something happened—I was no longer with my old class. I wasn't with the Chicano and black students anymore, I was with the Jewish and Japanese students. My whole schedule changed, so that if I took algebra with them, my social studies was with them, and all of a sudden I found that I was in a new track. I was tracked with the academic kids.

"And once I was there, I could do no wrong. I found out that the Japanese and the Jewish kids were no smarter than I was, they just did more homework. And I never really understood until I was older why there were no Mexican or black kids in my classes. I was just too young to understand.

"The next year, in the 10th grade, I went to high school. There the counselor, whom I had to see before getting into any classes, tried to tell me I had no business in the academic track, that I should go into industrial arts. He said, 'You haven't done all that well in algebra and all these other courses anyway, and I really believe that you should be in industrial arts,' which is where all the Mexicans and blacks were, where you took metal shop and machine shop and wood shop.

"For some reason—it wasn't a strong motivation toward science, I just took a personal dislike to this person—I became ornery and said no. And we left that session with me starting high school on probation; if I didn't have all Cs at the end of the first semester, he would put me in industrial arts. Well, that was all I needed, I hated that guy! I just wanted to see the look on his face when I gave him all As, which was something I had never done in my life.

"You know, I could thank that guy for doing that, but the fact of the matter is, much later in life I talked to my other friends from high school, and they went along with him. They possibly wanted to go into the academic courses, but he talked them out of it. That was the typical kind of thing that happened.

"Of course, when you are going through it, you don't realize the injustice of the system. You don't realize that you have successfully squeezed through a hole in a system that is a wall that prevents other people from going any higher. You can't really see the injustice, you have to be older and look back to do that. Then you say, 'Damn it! It was problematic for me, but all the other Mexican and black kids who were just as smart as I was just got stopped. Their horizons and their opportunities were just nipped in the bud, they never got through it.'

"That system is still in place, and people don't understand that, especially policymakers, people in Washington. Sometimes I hear what they say and how they discuss the problems, and I wonder, have they ever really come to talk to a junior high school teacher who is teaching in a ghetto school? These people haven't changed, these folks still hold the kids down. And they are not evil people; that's just the way it is.

"In fact, the classroom teacher has a lot more prob-

Role of historically black colleges in educating scientists is changing

The role of historically black colleges and universities in the development of black scientists is in flux. Until as recently as the 1960s, not only were black colleges almost the sole places blacks could get degrees in science, they also were one of the few places a Ph.D. scientist who was black could find employment.

In recent decades, however, that picture has been changing. More and more, predominantly white schools are recruiting both black students and faculty into their science programs. "The new code word at universities is diversity," says William M. Jackson, a black professor of chemistry at the predominantly white University of California, Davis. "Universities have finally decided that it's important to get more minorities into science."

The resulting competition for both students and faculty is taking its toll on black colleges. Today roughly 70% of black students going to college are in predominantly white institutions. "Middle-class black kids have the same aspirations as middle-class kids of any ilk," says Henry C. McBay, a professor of chemistry with a joint appointment at two historically black institutions, Morehouse College and Clark Atlanta University. "They want to go—and they do go—to Princeton and Harvard, Yale and Rutgers, and so on. That's a fact of life, and I see nothing wrong with it. But it puts the historically black schools up against the wall when it comes to recruiting the very best quality of undergraduate student."

Black faculty recruitment is also facing stiff competition from nonminority schools. This can be illustrated by a recent attempt by Morehouse to hire a new black faculty member. "We didn't get him because some other place offered him $80,000, and he's just a young fellow, straight out of school," McBay explains. "He's a theoretical chemist, and Morehouse simply couldn't afford him."

Yet despite this competition, colleges and universities with predominantly black enrollments graduate more than half of the blacks who receive bachelor's degrees in the U.S. As Betty M. Vetter, executive director of the Commission on Professionals in Science & Technology, explains, "The assumption has been that the reason black students graduate from black schools at almost twice the rate that they graduate from mixed schools is that black schools have lower standards. But that's not the truth; if it were, so many of these graduates wouldn't be going on to get Ph.D.s. The historically black colleges are a nurturing source. They say to a student, 'Of course you can do it.' They have the black faculty, insofar as anybody has black faculty. They offer the role models."

What they don't offer, with rare exceptions, are well-equipped, state-of-the-art laboratories or the attraction to faculty of world-class research programs. "Black colleges need as many resources, at least, as the white colleges and universities have, and they don't have them," Jackson says. "I've taught at both kinds of schools, and I can tell you absolutely that the black schools don't have them."

Nonetheless, Jackson agrees with Vetter that black colleges often provide a better undergraduate education for black students than do schools whose enrollment is predominantly white. Jackson, who as an undergraduate studied chemistry with McBay at Morehouse, says, "A college education is more than what you get in the classroom. It's also what you learn about yourself as an individual, which helps you to believe that you can pursue goals and targets that are at the highest level. There's no question in your

lems to deal with now, so they are even more ineffective. They've got drugs and teenage pregnancies and other things to worry about. These are not evil people. It's just that their expectations for minorities are different. It's institutional racism that's built into people. It basically says that what's good is what's like me.

"I went on to UCLA, which was a totally impersonal environment. You don't even get to meet a faculty member until your senior year. You are just one of a thousand people sitting in a classroom. They don't know you, they can't discriminate against you. It is totally impersonal.

"It was an accident that I went to graduate school. My parents had never even finished high school. They were so overwhelmed with the idea of my going on to college that they thought when I finished that it was the most fantastic thing. They had no idea that I was a lousy student, lousy in the sense of not working to my potential. The fact that I was graduating was a big thing to them, but I had a 2.65 grade point average. I never studied on weekends. I was the most unmotivated college student you ever met.

"By the senior year, I had small classes. My class in instrumental analysis had only 20 people. The professor knew me, and he knew most of the people in the course. They were opening up a brand new graduate school at [University of California] Riverside, and they had trouble recruiting students for it. The recruiter was a close friend of my professor's, and the professor said, 'You know, this kid over here, he's not a very good student, but actually, he's a lot smarter than what he accomplishes.'

"So the recruiter came to see me and invited me to go to Riverside. And my faculty adviser at that time said, 'Can you get me some Bs this semester, to show us that you are capable?' And I said, 'Why not? You want Bs? You got 'em.' It seemed a better alternative than the Army, which is what I thought I was going to do when I finished college.

"So I went to graduate school, and that just changed my life. I got totally into science. I left East L.A. and moved on campus. I had money in my pocket for the first time. I didn't hang around with the guys anymore. I stopped doing all the troubled kinds of things you get into in East L.A. I went from an unmotivated student with a 2.65 grade point average to a straight A student, zooming through the cumulative exams, eating up research. It just changed my life entirely.

"The faculty person I was working with moved to Dartmouth College. I had passed all my exams, so the chemistry department arranged for me to finish my research at Dartmouth. I mailed them a thesis, and they

mind when you are at a black college that you can go on and get a Ph.D. because the professors are black, and students before you have done it. You feel that if they have done it, you can, too.

"But at a large white institution like the one where I am now, although we've had blacks get Ph.D.s in chemistry over the past 10 or 15 years, I don't know how many of the black students here know that. These students really don't have a lot of role models in white institutions, and I think that must affect their expectations of whether they can succeed in various scientific fields."

Black students go to black colleges for a variety of reasons, says Jesse M. Nicholson, chemistry department chairman at predominantly black Howard University in Washington, D.C. Their parents, if they went to college, probably went to these schools, and so encourage their children to do so as well. Similarly, the successful black professionals that young blacks see went to black colleges. "There's a feeling of being closer to one's heritage here," he adds.

In addition, black schools seem safer to many students. They are seen as places where students won't have to deal too often with racism and thus can focus their attention on studies or on social interactions with other blacks. And they are places where "teachers are aware of the problems that black students may face and are willing to go the extra mile to help students," Nicholson says. Good teachers do that at majority institutions, too, Nicholson says, "but we have the reputation for doing that."

Says McBay: "There are people who say there is no further need for historically black colleges. But there is one fact I can present for the need to keep these schools that can't be refuted. There is no refutation of the fact that maybe 5% of the entering class at Morehouse College could be accepted into Harvard, but by the end of four years, 40 to 50% of the graduating classes from Morehouse go to the Harvards and the Princetons and earn advanced degrees in competition with people of all kinds. If you didn't have a Morehouse College, if you didn't have a Clark Atlanta University, those human resources would, very probably, be lost."

"The fishnets that are thrown out by the Harvards and the Princetons and the Yales don't encompass little towns in the rural South," McBay continues. "We get some rather remarkable young people who come from far back in the boondocks and who are poorly exposed at the beginning, but who are very gifted and, given the opportunity, outstrip kids who come from Detroit and Los Angeles. Black colleges may be relegated to the role of gleaners in education. But even if that happens, there is justification for black colleges, because there's a large pool of human resources that would not be developed if we were not there."

In fact, majority institutions are working harder to retain and graduate their black undergraduates. Such schools "are finally waking up to the fact that there are good models for retention of minority students," Vetter says. "There are some basic things that almost always are required. If you want to increase your minority students, don't go out and recruit five blacks, five Hispanics, and one American Indian. If you are going to recruit 11 students, make them all black or all Hispanic or all American Indian so that they have a group to work with. Don't try to bring minority students into a situation where there's nobody around who is like them."

Another effective strategy for retaining minority students that many engineering programs use is to bring the students to campus the summer before the fresh-

mailed me a Ph.D. After that I did a couple of postdocs—one at the University of Pennsylvania and the other one at California Institute of Technology—and then I joined IBM.

"Beginning with graduate school, I got straight As and loved research. And I loved finding out that here was a field where people don't care about the color of your skin. You can become famous without people ever meeting you, just from their reading about the work you've done. I'm Mexican, and these guys don't know it, and this one is Chinese, and this one's German, and this one's Greek, and it doesn't mean anything to them. It's just amazing. A great, great community of people to belong to."

Clearly Castro's is a success story, and the research career that he has is an exciting and satisfying one for him. By and large, successful scientists, whatever their race, feel that way about their work. In a survey of its members conducted last year, ACS found between 80 and 90% of respondents felt that their work was challenging and their working conditions good. This satisfaction level held true for blacks, Hispanics, and whites. There was slight variation between ethnic groups in responding to the general statement, "I'm satisfied with my job." Here 82% of white, 74% of black, and 87% of Hispanic ACS members expressed agreement.

But not all minority scientists share Castro's view of the color blindness of the scientific community. Especially among blacks, many believe opportunities for advancement, particularly in industry, are not so good for them as they are for whites. In the ACS survey, 72% of whites and Hispanics—but only 50% of blacks—thought their employers paid them fairly. In the same vein, 69% of white respondents and 67% of Hispanics thought their chances for professional advancement were good, but only 40% of blacks thought so. And chances for managerial advancement were seen as good by 62% of whites, 61% of Hispanics, but only 29% of blacks in the ACS survey.

Unlike Hispanics and American Indians, blacks have made essentially no progress in the past two decades in increasing their fragile toehold in the scientific professions. At least part of the reason may be because young blacks have heard of the dissatisfaction of practicing black scientists and perceive that their own opportunities will be better outside science.

"Historically, industry has not employed black scientists and engineers," says James Evans, National Organization for the Professional Advancement of Black Chemists & Chemical Engineers (NOBCChE) president. "When students are deciding what they want to become, they look where the opportunities are. You don't

man year for a concentrated catch-up program if, as many minority students do, they come from a high school that did not offer them as many upper level courses as their white counterparts are likely to have had. "You can't hold them back once the rest of the students get on campus, or you'll have insulted them," Vetter says. "It isn't that they are not bright—you wouldn't have selected them if they were not bright and able and interested—but many of them simply don't have the background. They come out of high schools that didn't offer calculus, so, of course, they didn't take calculus, or maybe they didn't get physics or chemistry or something else that they need. Most schools, whether minority or not, now understand this."

Weighing the relative advantages of mostly white and mostly black schools is an individual matter, and young blacks will probably continue to choose to go both places. Bertram O. Fraser-Reid, a black professor of chemistry at predominantly white Duke University, argues, for instance, that especially for future chemists, excellent laboratories may be the most important single factor in deciding what school is best. "People are turned on to chemistry, by and large, because of the excitement of the laboratory experience," he says. "Science is a culture, and part of that culture rubs off on you when you are in the lab all the time. Unless a school has the personnel and the resources to run an excellent laboratory, it is a real problem for it to mount an exciting undergraduate program in chemistry. And many minority students are going to minority schools where this situation does not exist. It gets very difficult for them to be turned on to chemistry, even though their teachers are very dedicated, are very good mentors, and are excellent teachers.

"I've had so many young men and women talk to me with concerns about going to majority schools. They are worried that they will lose their black culture and about whether they will experience corrosive racism. My advice is that, yes, you will experience racism. I did when I went to school in Canada. On the other hand, many of the young men and women I met there are my best friends today. So, although you will experience it, I think you just have to rise above it. In my view, that situation will never, ever disappear. It is nonsense to say that I cannot go to that school until every vestige of racism is gone. It will never happen.

"Regarding loss of culture, I assure them that although I left the West Indies 30-odd years ago, all I have to do is step off the plane in Jamaica, and I know where I came from. I don't believe that four years in a foreign institution can make you lose your culture.

"I also advise them that science is also a culture, and it is a universal culture that you are going to share with people of all races. There is only one science, whether you are black, Indian, Chinese, or white. And if that is the case, you ought to be where that culture can be best absorbed. The way to absorb that is with other people who are trying to absorb it at the same time. Not necessarily with people who are focusing on other things. That's the way I see it."

"People have criticized me by saying that most of the black scientists who are practicing today are the product of the historically black schools," Fraser-Reid continues. "And I do accept that; that's the way it had to be, given the racial climate of the time. But I am talking about the cost of mounting a scientific education in the 1990s when instruments cost so much and setting up an undergraduate lab costs so many hundreds of thousands of dollars."

prepare yourself for a field or discipline where you can't get a job. I'm in a position to look at salaries, and there is a real tendency for minority chemists—blacks, in particular—to be lower ranked than their white peers, even when you adjust for length of service, level of degree, and so on."

Philip Merchant Jr., a black program officer with Exxon Education Foundation in Irving, Tex., and immediate past president of NOBCChE, points out that, like whites, many black children decided to study science during the post-Sputnik era of the late 1950s. These people entered the work force in the late 1960s and early 1970s "and quickly realized that their opportunities were not equal. That caused the children of those blacks to not want to study science. So now we have a situation, perpetuated from generation to generation, where fewer black children believe there are opportunities in science for them."

If anything, the climate for black chemists in industry is more hostile now than it was a generation ago, suggests Morehouse and Clark Atlanta's McBay. McBay, who has been teaching chemistry at historically black colleges for more than 40 years, says that in the late 1960s and early 1970s, the people in positions of power in companies were what he calls "wholesome" whites. "The society, the climate, was such that they would have been ashamed to come out and declare themselves as being prejudiced people. But now, with political leadership such as [former President] Reagan has displayed, we have a climate in which people are no longer reluctant. They are up front about their prejudices. And this changes the climate in the workplace."

Not surprisingly, such claims do not go unchallenged by chemical industry employers, and neither McBay nor anyone else is suggesting that all employers are the same. Says Wil D. Carpenter, vice president of Monsanto Agricultural Co.: "You cannot imagine the pressure that's put on me, personally, running a 600-person scientific organization, to get blacks into management positions. If I thought there was anything like an 'old boys' network that was keeping blacks out of management positions, believe me heads would roll. At Monsanto, that is just not the case."

The perception of limited opportunity to move into management positions is something that many companies are working very hard to change, says Carl A. Bauer, director of personnel resources at Dow Chemical USA. "I think even the best companies will tell you that a lot of their minority employees—blacks especially—say they don't see career opportunities. That's why some people quit," Bauer says.

"We've looked at how the minorities who are in the

top level of Dow are doing," Bauer adds. "They're doing fine, but there aren't enough of them. What about the next tier? They are doing fine, but there aren't enough of them, either. When we look at the entry to middle-management tier, we find there are quite a few minority people here. Now we're asking, are they getting a fair share of promotion and top performance ratings—and if not, why not? This examination has resulted in the development of an employee development process that, like most good programs, works not only for minorities but for all our employees. Upward mobility is the name of the game—it's our number one goal."

Robert K. Armstrong, manager of professional staffing at Du Pont says, "Unquestionably, what has happened in the past is that blacks have had great difficulty making it in industry. I think the atmosphere for upward mobility in companies has made fantastic strides in the past two to four years. But having said that, you have to realize that upward mobility in a company is not a short-term proposition. You'd be hard-pressed to name one vice president at Du Pont who has less than 15 years' service. Even if the atmosphere is right, you can't promote people from very low to very high. So it will take time, and the perception will be that the change is not going very fast."

"I believe that at the upper levels of almost any organization, they want more blacks to study science," NOBCChE's Merchant says. "They know it is important to them. But I'm not truly convinced that this idea has trickled down to the bottom of any organization. I don't just mean industry, but the government and our educational system, too. Until that is the concept at all levels—that there is a need for equal opportunity for everyone, whether you are black, Hispanic, or whatever, you are not going to have a significant increase of blacks in science."

If the overall picture of efforts up to now to increase minority participation in science is a gloomy one, it is certainly not a picture without bright spots. The Quality Education for Minorities Project found, for example, that although all the answers are not uniformly in place, "we do know how to create a school that helps even the most alienated child feel part of a family of learners ... [and] how to instill a dream of a career in science in a young girl from rural Puerto Rico." The project found literally hundreds of programs already in place that are working. Two decades of experience have shown "that we know what the problems are and what to do about them," its report concludes.

Several federal agencies—including the departments of Education, Energy, Agriculture, and Defense and NSF—have programs that aim at increasing minority participation in science and engineering. But the pioneer effort among federal agencies—and the one that is most frequently held up as a model of what federal involvement can do—is that of NIH.

NIH began to address the shortage of minority biomedical scientists in 1972 with a program called the Minority Biomedical Research Support program (MBRS). This program focuses on the institutions that traditionally graduate the largest numbers of minority students. The program's initial 38 schools were primarily historically black colleges and universities, but over the years it has expanded to include schools—particularly in the Southwest—that have predominantly Hispanic enrollments, as well as a growing number of large, inner-city universities that attract large numbers of both black and Hispanic students.

"The intent was to build a capacity to do research and research training at these institutions," explains program director Ciriaco Q. Gonzales. "There was not much capacity there, but these institutions were the ones that were responsible for most minority Ph.D.s in biomedical sciences as well as the medical degrees. As far as training minorities was concerned, they were the best."

"Yet they needed facilities," Gonzales continues. "They needed research for faculty. Most of these institutions had teaching as their major function, so we needed to give these faculty time off from teaching to get into research. They needed equipment and renovation of laboratories. And the students needed not only the sort of environment that we set up with the faculty in these institutions, they also needed financial aid. Instead of pushing a broom or whatever they had to do to go to school, they needed financial support, along with the environment and the mentorship to pursue careers in science."

This multifaceted program began with $2 million to spend at 38 institutions. It now operates at about 100 schools with an annual budget of about $42 million. Schools can be at any level—from two-year colleges to Ph.D.-granting institutions—as long as their enrollment is predominantly from underrepresented minorities or they serve a significant minority population in an important way. Montana State University, for example, has an MBRS program, even though minority students make up less than 10% of the school's total enrollment because most of its minority students are American Indians and the school has made a major commitment to provide education for students from each of the state's seven American Indian tribes.

"The ultimate success of our program would be to flood the market with minority Ph.D.s and M.D.s," Gonzales says. That hasn't happened yet, he acknowledges, but "we have been putting people into the pipeline. About 500 students from our program get bachelor's degrees every year. Around 80% of these go on to some form of postgraduate study. About 50% of those go into the health professions—medicine, pharmacy, dental school, or veterinary school—and the other 50% end up in Ph.D. programs in graduate school."

What happens ultimately to program participants is not so well known. "Unless you have a screening program for tracking students that is very elaborate, you can't keep track of them all," Gonzales says. He knows that more than 400 former participants have earned Ph.D. degrees and over 800 now have medical degrees. Over 16,000 students have completed the program, but many of them haven't had time since getting their undergraduate degrees to have completed a doctoral program.

NIH has a second program to increase minority participation in biomedical fields. Intended to complement the MBRS program, the Minority Access to Research

Careers (MARC) program focuses on helping talented minority science majors make the transition from college to graduate or medical school. Each year MARC supports about 500 juniors and seniors at minority institutions. Of the 2700 students that the program has supported since it began in 1976, 80% have gone on to professional or graduate school—compared with the national average of less than 20% of minority science majors who do so. And three quarters of those who start a graduate program complete it. Of that number about 60% earn Ph.D.s, the rest get medical degrees.

"We identify the very brightest students," explains Elward Bynum, director of the MARC program. "We assume that a student with an honors average, given faculty support and monetary support, will translate into an individual who will work harder to improve even that average." Like the MBRS program, MARC also works on curriculum development at the schools where its students are and provides student training equipment, such as water baths and microscopes.

One of the key features of the MARC program is its requirement that all participants leave their home institution and spend at least a summer at a major research institution in some other part of the country. "They go out and gain a lot of confidence," Bynum says. "They see first-rate research laboratories and participate in first-rate research. They work side by side with other undergraduate students, as well as graduate students and postdocs. They get a good feel for what they can accomplish, once they set their minds to it. It works extremely well."

MARC began with a $4 million annual budget, which "may have been commensurate with what we were able to support and still maintain the quality of participants that we wanted," Bynum says. "We just didn't have a large number of minority students interested in biomedical research careers in the beginning." But in recent years the number of high-quality candidates for the program has doubled, in large part, Bynum believes, because present and former participants have become excited about the opportunities they see in biomedical research and are recruiting their fellow students into research careers. For 1992, the program has requested a budget of $15.6 million.

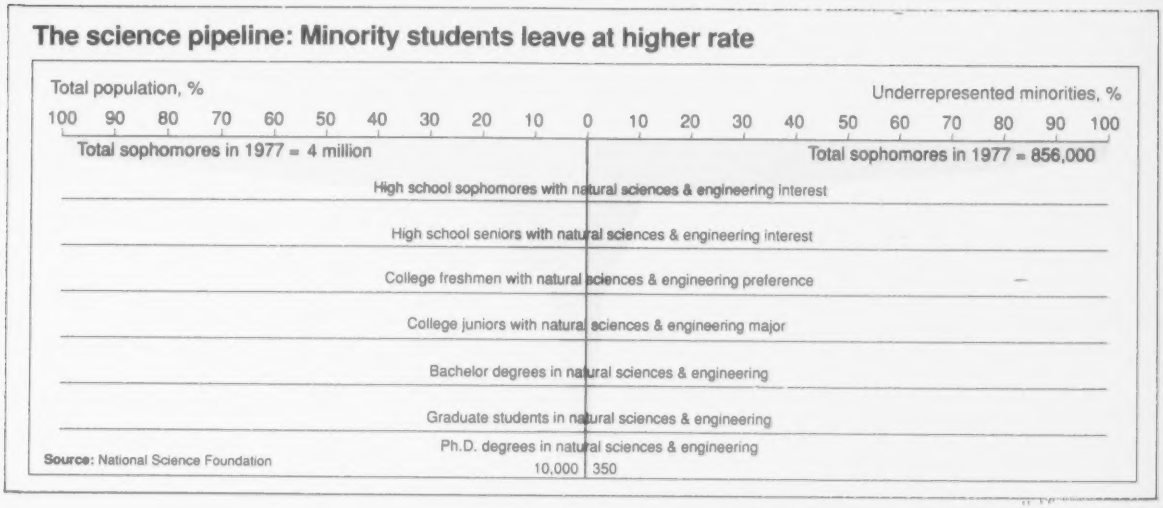
MARC is currently expanding in two directions: Beginning this year it will provide student stipends and other support to freshmen and sophomores, as well as juniors and seniors, at its participating institutions. And the program will also now provide minority students with support for graduate school even if they attend predominantly white institutions.

Several nonfederal programs have also been playing an important role in increasing participation of underrepresented minorities in science. For example, the Southeastern Consortium for Minorities in Engineering (SECME), a consortium of 28 engineering schools in eight southeastern states that operates out of Georgia Institute of Technology, runs science and math enrichment programs at 240 of the region's high schools. The program establishes partnerships between local schools, the engineering colleges, and industry, explains founding executive director Carolyn Chestnutt Thorsen. With the approval of the local superintendent or school board, a team of teachers within each school plans the program, as well as reviews and evaluates its success. Industry provides funding and minority engineers who serve as role models for students. The engineering schools put on a two-week training program for the high school teachers each summer, giving them hands-on exposure to what engineers do. "Local planning is critical," Thorsen says, "What works in one school won't work in another."

Although aimed specifically at increasing minority participation in engineering, SECME and programs like it also increase minority access to science careers. The program now reaches 18,000 high school students, 93% of whom are black. Each year for the past 10, 85% of the program's graduates have entered college—compared with the national average of 29% of black high school graduates entering college. And 45% of those in college major in math, science, or engineering. "We've been shocked, quite frankly, by our success," Thorsen says. "The improvements have been beyond our expectations."

C&EN staff photos

Merchant (far left): belief that opportunities are few. Danek: a question of access. Evans: hard work but great rewards


The science pipeline: Minority students leave at higher rate
Total population, %
Underrepresented minorities, %
100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100
Total sophomores in 1977 = 4 million
Total sophomores in 1977 = 856,000
High school sophomores with natural sciences & engineering interest
High school seniors with natural sciences & engineering interest
College freshmen with natural sciences & engineering preference
College juniors with natural sciences & engineering major
Bachelor degrees in natural sciences & engineering
Graduate students in natural sciences & engineering
Ph.D. degrees in natural sciences & engineering
Source: National Science Foundation
10,000
350

At the University of Puerto Rico, Project CAUSA (Comprehensive Activities to Upgrade Science & Academics) provides science and mathematics enrichment programs for 300 talented Puerto Rican high school students each year. The program provides special math and science curricula, materials, and laboratories to these students in Saturday programs throughout the year and in summer camps. Participants can also participate in research at local universities, be tutored in English, and receive guidance in preparing for college. Like SECME, the program also works with the parents of student participants and offers training for high school science teachers. Since its founding in 1985, every one of Project CAUSA's graduates has gone on to college, with 85% of them majoring in science or engineering.

Both SACNAS and NOBCChE concentrate their efforts on providing young minority students with opportunities to meet and talk with practicing scientists of their own ethnic group. At its annual conferences, for example, SACNAS organizes an evening of informal conversations between practicing research chemists, chemistry graduate students, and college chemistry majors. Similar discussions occur simultaneously among people in other scientific disciplines. In groups of 10 or 12, the undergraduates are encouraged to ask whatever they want to know about going to graduate school and preparing for a career in research.

Almost identical conversations are a highlight of NOBCChE's annual meetings. Here, too, the national meeting concentrates on students, bringing them in from all around the country and giving them a chance to talk to one another as well as to practicing minority scientists. NOBCChE is organized into local chapters in which black chemists work throughout the year with minority students in local high schools.

AAAS's Linkages Project aims to get community groups of all kinds involved in improving science education and opportunities for minorities and other underrepresented groups. Part of that program—the Black Churches Project—provides training and educational materials for church groups interested in providing hands-on science and mathematics projects for black children. More than 500 churches have gotten involved, and last month AAAS held the first of five regional workshops aimed at attracting 180 more churches to the program. Local projects help explain to parents the importance of early math and science education, set up workshops for teachers to learn how to run hands-on science projects, organize field trips to science museums and zoos, plant gardens, and run science-related projects for Boy Scout and Girl Scout troops.

ACS, too, has a long-standing commitment to programs that increase minority participation in science. Project SEED, ACS's career development and social action program, has been operating since 1968. This program focuses on providing exposure to scientific careers to high school students from economically disadvantaged backgrounds. Though the program is not specifically aimed at minority students, more than 60% of the student participants have been from underrepresented minorities, says Sylvia A. Ware, director of ACS's education division, which supervises this program.

In the SEED program, talented high school students spend 10 weeks during the summer conducting research in local academic, industrial, or government laboratories. During this period, the students develop a close relationship with the researchers they work with, and these researchers provide career guidance and serve as role models for the students. In 1989, the program involved 190 students at 78 sites.

In conjunction with NSF, ACS also offers a program called the Young Scholars Partnership, in which 21 high school students—19 of them from underrepresented minorities—supplement their Project SEED experience with a school-year program of counseling, instruction in the ethics and philosophy of science, and special field trips. A highlight of this program is a trip to the SACNAS annual meeting, where the students present posters on their research projects.

ACS has also produced a videotape, called "Working It Out," aimed at pointing out, particularly for black high school students, that there are career opportunities in chemistry for them. The tape features discussions with black high school students, college students, and newly graduated chemists in the workplace.

With all these programs in place, why haven't minorities been making faster gains among scientists and engineers? Several factors may be important. NIH's Bynum points out, for example, that at the same time NIH was setting up its programs to encourage more minority participation in biomedical sciences, federal undergraduate student support programs were changed from grants to loans, which probably decreased the overall number of minority students going to college.

Another troublesome question is just how effective many of the existing programs are. Data simply don't exist to measure the success of many programs. Marsha Lake Matyas, director of the Women in Science Project of AAAS, tried in 1989 to assess the effectiveness of programs at more than 500 colleges and universities that were aimed at increasing participation of women, minorities, and the handicapped in science. Her chief finding was that many programs don't collect the data necessary to evaluate their effectiveness. Only about half the programs she examined know how many of their participants received undergraduate degrees, and many fewer keep track of participants through graduate school and into their eventual careers.

"I have no way of proving this," says Monsanto's Carpenter, "but I believe that if you took the total resources that are available in the St. Louis area to address this issue and used them in a more productive way, you could probably double or triple their effectiveness. There is no central repository where somebody has listed an inventory of the people, organizations, and funds that are available in this area. I've got to believe that there's duplication and there are gaps. We're doing things that should be 30th on a list of priorities and ignoring things that should be first, second, or third. On a national basis, if we could find some better way to coordinate and inventory the resources we've got without creating some monstrous bureaucratic machine, we could do a lot more."

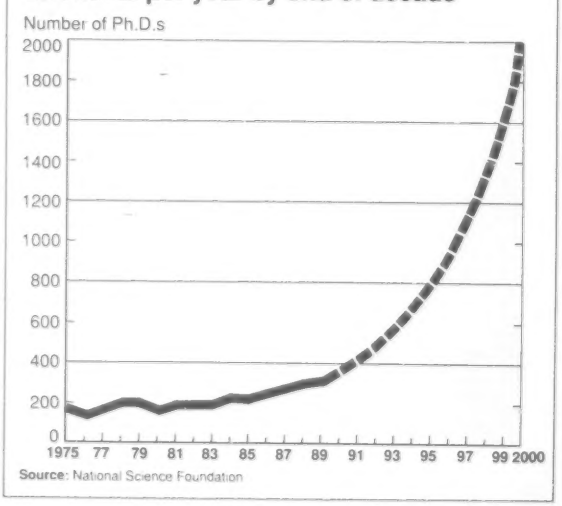
The essence of what Carpenter is calling for may be a role that NSF is trying to take on. Over the past four years, that agency has begun a major new program to increase substantially minority participation in natural sciences and engineering.

In 1986 NSF began looking at minorities, women, and other groups that were underrepresented in science in a more quantitative way. When it compared the total population and minorities, it found that in the minority population, only about 10% of high school sophomores said they wanted to become scientists or engineers, compared with 18% of all high school sophomores who said they wanted to do so. Another major difference occurs between the freshman and junior years of college. In the total population, 63% of freshmen who say they want to study science or engineering will be majors in those fields two years later. For minorities, however, only 35% of the freshmen who want to study science or engineering will actually be doing so by the time they are juniors.

Out of this analysis grew what NSF's Danek calls "a well-reasoned set of programs to attack this issue in a systematic way at every step along the pipeline." The program calls for intervention at three levels—precollege, undergraduate, and postgraduate. The keystone of the precollege programs are 12 comprehensive regional centers for minorities. Established in 1987, these regional centers now have a combined budget of about $15 million per year. "They engage in a whole range of programs," Danek explains, "to improve teacher quality, to bring kids in for day camps, for summer programs, for Saturday academies, to develop leadership by working with parents and counselors. We want to turn around the situation so that what happens in the classroom for minority students builds their sense of confidence, accomplishment, and reward. When people succeed at something when they are young, they like it. That's what we are trying to build."

The middle piece of NSF's comprehensive program—the undergraduate component—is also the newest. Called the Alliances for Minority Participation, the program is in its first year. "We've asked the universities, industry, the states, and the cities to come together and come up with a coalition in a region that is going to significantly increase minority undergraduate participation in the next 10 years," Danek says. "We offer five-year grants at $1 million per year, plus a lot of cost-sharing and foundation and other support." The goal of this part of the program is to increase the number of bachelor's-level degrees in natural sciences and engineering going to members of underrepresented minorities from the current 14,000 per year to 50,000 by the end of the decade and to increase the number of Ph.D. degrees awarded to underrepresented minorities in these fields from the present 350 per year to 2000.

NSF aims to produce 2000 minority Ph.D. scientists per year by end of decade



Source: National Science Foundation

To meet these goals, the alliances are going to have to dramatically plug some important leaks in the pipeline that produces science and engineering professionals. "We want to see a dropout rate for students in these alliances that is almost nonexistent between the freshman and junior year," Danek says. "In three to five years, we are looking to see changes. If we are going to go from 14,000 baccalaureate degrees per year to 50,000 in 10 years, we've got to see a 15% increase every year."

The alliances will actually focus on two points in the pipeline where minority students are lost—the high attrition period between the freshman and junior years in college and the transition between finishing high school and entering college. As NSF's Williams points out, there is a pool of minority high school graduates "who complete high school having taken all the right math and science courses and whose scores on college placement tests indicate they would be successful in undergraduate science or engineering majors. But about 35% of these youngsters don't go to college. So part one of the program is to engage that 35%."

The program is ambitious, Williams says, because it aims to engage "not a fraction of the 35%, but the majority of them and attract them into colleges and universities." It's also realistic, he suggests, because its success "doesn't depend on learning how to get an increased number of minority students through the precollege sector. The students have already done that themselves; they are simply not going on to college, or if they are going on, they are not staying with their intent to major in science or engineering."

The third component of NSF's program is a set of programs designed to improve minority faculty research and training opportunities. The effort pulls together two programs addressing these issues that NSF began in the early 1980s—the Research Improvement in Minority Institutions Program and the Minority Research Initiation awards and planning grants—and adds to them a newer program (begun in 1987) to develop large-scale minority research centers of excellence.

In this large-scale program, "we're working with six minority institutions now and we are going to go to eight," Danek says. "We're trying to develop the research training capacity at eight of the most productive research-oriented minority institutions. We know that there are a number of minority students who would go to a high-quality program at one of these institutions who won't go to programs at Stanford or Harvard or some other first-class majority research institution."

Altogether, the three components are requesting $45 million in the 1992 federal budget, up from about $7.5 million that their predecessor efforts received in 1986. "These are not NSF's only efforts with regard to minorities," Danek points out. "These are our targeted and focused efforts. NSF has an education and human resources budget request for 1992 of $390 million for a set of activities that the foundation believes will help solve some of the educational problems in the country.

"At the same time, we know we are not living in an ideal world. We need specific intervention programs for minorities at certain points along the pipeline. You can look at the $390 million education effort and think of the $45 million as an intervention that is going to perturb the system. The effect of the two systems interacting will generate a much more effective system over the long haul. Eventually, the objective of these programs is to no longer be needed as minorities, women, and persons with disabilities, who are now underrepresented in science, become part of the mainstream in science."

Although $45 million is a substantial amount of money, NIH is already spending $56 million on its minority intervention programs and Williams estimates that funds from all sources currently directed at this effort total on the order of $200 million per year. How realistic is it, then, to expect another $45 million to produce a nearly fourfold increase in minority scientists and engineers at the bachelor's level in just eight years?

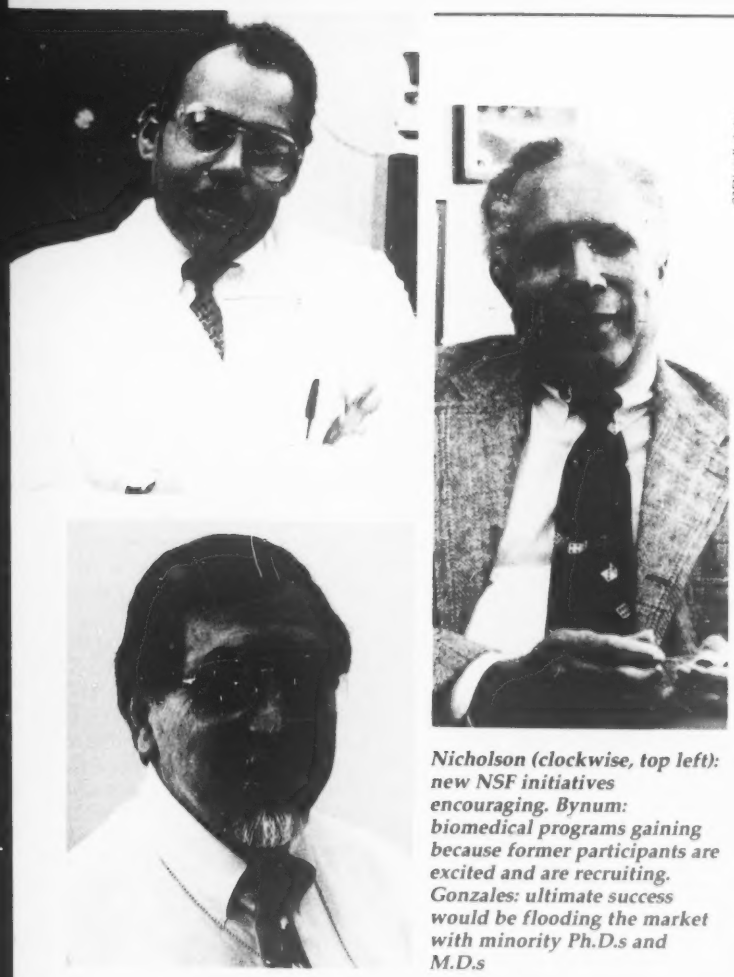
"Frankly, given the magnitude of the effort, even if its success rate is only 30% of what we envision, it still would be an extraordinarily positive undertaking," Williams says. Meeting 30% of NSF's goal would roughly double the number of minority scientists and engineers graduating each year. "I think anything less than a doubling of minorities would not be a success," Williams says, "but if we could, in fact, double the current level of production, that would be an extraordinary contribution."

NSF may meet its goals by the year 2000, suggests AAAS's Malcom. "If people have to go around and basically rediscover how to do everything, they will not make it," she says. "But if NSF will provide not just money, but help in building on the experience and talent that we already have, we can meet these goals. If they don't do it at all, there's no way it will happen. But if they do it right, we have a chance."

"I'm very encouraged with NSF's new initiatives," says Jesse M. Nicholson, chairman of the chemistry department at Howard University. "The idea of starting very, very early to try to convince young people that there are tremendous numbers of opportunities in science is something that is very much needed." As to whether NSF will actually meet its goal of graduating 2000 Ph.D. scientists and engineers per year by 2000, Nicholson says, "You set your goals high. I think if output doubles in that time, it would be a welcomed improvement. But no, I don't think NSF's goals are going to be realized unless a great deal more money is put into this effort. You'd have to make it extremely financially rewarding, sort of buy people into the area, to meet those goals."

Thirty years ago, in the post-Sputnik era, a federal program called the National Education Defense Act basically did that, Nicholson says. "Students got $2000 to $2400, and at that time, that was good money," he explains. "There was a need to get scientists, and that level of financial support was enough to sort of drag students into the field. And then, of course, once they got into the field, they saw that the work was really fun, and they liked what they saw. Now there needs to be something like that again."

Says AISES's Hill: "The gains that I am seeing are promising, but we can't put a Band-Aid on a long-term problem. The investment is generational, and I don't



C&EN staff photos

Nicholson (clockwise, top left): new NSF initiatives encouraging. Bynum: biomedical programs gaining because former participants are excited and are recruiting. Gonzales: ultimate success would be flooding the market with minority Ph.D.s and M.D.s

think we can fix up 200 years of educational deficits in one or two funding cycles. ... Getting an engineer is a process and not an event, and the year 2000 is not a magic point when we are going to have this process completed. If it thinks that way, NSF will be disappointed. I'm not hopeless, I'm just saying we've got a long way to go. We haven't even approached the halfway point yet."

"We're going to change things," says NOBCChE's Evans. "We're going to make it happen for a number of reasons. One of them is that there's talent among minority young people that's waiting to be used. But the real reason is that science is fun. We scientists work hours that we would probably do for free if we had another job and someone said, 'Here's a laboratory, you can go over there and play whenever you want.' We do science because it's fun and stimulating, and that's not cultural; it's probably true for anyone you talk to. There's clearly a lot of hard work necessary to become a scientist, but the rewards are great. I can't tell you when it's going to happen, but for all these reasons, we're going to make it happen."

But there is some real time pressure on present efforts to try to improve minority participation in the sciences and engineering. Long-time observers point out that present efforts will need to start showing results soon—and substantially better results than earlier programs have—if they expect to continue to be widely supported. These efforts, after all, are fueled in large part by the pressing concern that shortly there may not be enough scientists and engineers to supply the nation's need for workers in science and technology fields.

And there are other ways to meet the need for scientists and engineers. For instance, the immigration laws could be changed to make it easier for foreign graduate students to remain in the U.S. once they complete their studies. Foreign students continue to flock to the U.S. to study science and already make up an important component of the country's scientifically trained work force. Immigration policy could also be changed to encourage foreign-trained scientists to immigrate to the U.S.

There are two ways of responding to the expected shortage of scientists, NIH's Gonzales points out, "We can either train our own people here, or we can go get foreigners. Which way we are going to go is up for grabs right now."

For several reasons, training our own seems, for now, the preferable option. As Roosevelt Calbert, head of the minority programs section at NSF explains, "a good analogy is the oil crisis. We have become dependent on somebody else to send us our oil. If we do the same thing in human resources, we will be in trouble. If we lose our capability to train our own personnel, our own work force, if we have to depend on someone else to send us those trained people, we'll be in the same kind of trouble that we were in the oil crisis."

There may be even more important reasons than national security for choosing to improve minority participation in science. "We have a larger issue here," Malcom says, "about whether we really think that talent is distributed within all the groups in our society and whether we think we can hold a democratic society together where only certain people do certain things, and we don't look to other groups to provide those skills. I don't think that's the way a democracy works; that's not what America is about. So the questions really are about equal opportunity, equal access, developing human talent, and allowing potential to be expressed, as well as meeting national needs for people to be involved in the enterprise that's called science." □

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